

of irrigation. The records confirm the view held by live stock men at the time, which was that a successful prosecution of agriculture on the uplands would not be attained, except perhaps in a few localities where, by reason of the topography, the rainfall is ordinarily greater than on the plains. There is no reason to believe that the rainfall in recent years is any more or any less than it was before the disappearance of the buffalo from his great feeding ground. The stand of grass on the plains, however, might be taken by some persons as an indication of a diminishing instead of an increasing rainfall. We all know that during the past twenty years the ranges have been taxed to furnish sufficient pasturage, and, as a consequence of overstocking, the grass has been cropped too close. At present the arroyos carry off the bulk of the rainfall, but such would not be the case were the run-off checked by grass left from the preceding year. At the same time the old grass would reduce the rate of evaporation of such moisture as soaks into the ground. These facts, rather than any difference in the rainfall, are responsible for a poor stand of grass on so many of the ranges.

During recent years the stockmen of the far West have become more and more interested in farming operations, and such as do not themselves engage in the industry are only too glad to buy hay if it is to be had. The rainfall is very uncertain in the arid region, and the volume of water available for irrigation precludes any material extension of the agricultural districts. It is true storage reservoirs would improve the situation, but the expense of such undertakings would be too great for private enterprise. There is no doubt that the flow of our streams during summer and fall could be materially improved at a comparatively small cost. In the mountain districts there is a constant and generous flow under the ice in all the small streams during winter, no matter how cold the weather. To store this water for use during the following summer it is suggested that after suitable sheltered places have been selected the water be brought to the surface and allowed to spread over the ice. Even though only a small proportion of the flow be utilized, immense fields of ice could thus be formed, and if the site be protected from the west winds, the gradual melting would maintain a good flow throughout the season when water is generally scarce east of the mountains. It is believed that a concerted movement in this direction would prove profitable.

THE BAROGRAPH ON SHIPBOARD.

By JAMES PAGE.

On the pilot charts of the North Pacific and Atlantic oceans, respectively, for 1900, there is an excellent article by Mr. James Page, of the United States Hydrographic Office, explaining the use of the barograph at sea. The Richard self-registering aneroid barometer is now sold at a price equal to or less than the former prices for a thoroughly reliable simple aneroid itself; its mechanism is simple, it is handled more easily than the ordinary ship's barometer, and gives far less trouble in the matter of making and keeping records. We think it important to reproduce the diagram and the article by Mr. Page as an excellent illustration of the value of the instrument. Having used one ourselves for a long time on shipboard and having seen conservative old captains convinced of its value in the navigation of a vessel, we need only say that the experience of all justifies the statement that every sailing vessel and every steamer should have one of these self-registers in addition to its standard mercurial.

The accompanying diagram is a facsimile of a portion of the pressure curve drawn by the self-recording aneroid barometer on board the Alaska Commercial Company's *S. S. Portland*, Capt. C. E. Lindquist, during a voyage from San Francisco to St. Michael, Alaska, September 3-21, 1899. Owing to lack of space the diagram is limited to portions of the curve

included between Monday, September 11, and Wednesday, September 13, the position of the vessel at each successive noon being given under the date at the top of the diagram. In the lower portion are entered for the indicated hours the direction and force of the wind and the character of the weather, the Beaufort system of notation being employed throughout. These entries are copied from the log of the vessel and are made after the sheet has been removed from the cylinder of the instrument.

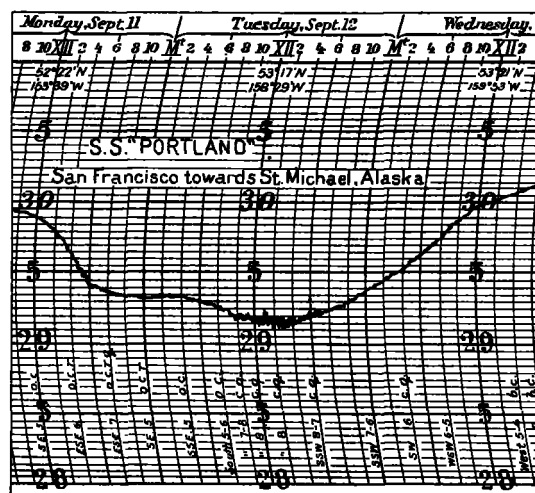


FIG. 1.

One of the most valuable results to be derived from the consideration of these barograms, as curves such as the present are called, is the evidence which they afford of the intimate relation existing between the state of the barometer and the direction and force of the wind. In the middle and higher latitudes of the North Pacific the direction of motion of the areas of low barometric pressure, which invariably accompany periods of stormy winds and foul weather, is in general eastward, the average path followed by the center of these areas being shown upon the Pilot Chart for the current month. Around the center of such an area, in accordance with the well-known principles of the law of storms, the winds circulate in a negative or anticlockwise direction. In advance of the center southerly and southeasterly winds will thus prevail, which will gradually shift to northwest as the center approaches and passes the observer's vessel, the shift taking place by way of north if the observer's position be to the north or left of the track, but through the south if it be to the south or right of the track. The barogram of the *Portland* and the accompanying wind and weather entries furnish an excellent example of the manner in which these shifts take place. At noon of Monday, September 11, in latitude 52° 22' N., longitude 153° 39' W., the *Portland* experienced a falling barometer and south-east winds of force 5, with overcast sky, all tending to show the existence of a center of low pressure to the westward. As the day advanced the barogram shows that the pressure diminished rapidly; that the weather became rainy and squally, and that the winds, while increasing in force, remained fairly constant in direction, conditions from which either one of two conclusions may be drawn, viz, either that the depression was for the time stationary but at the same time increasing rapidly in depth, or that the motion of the storm center was carrying it directly toward the position of the *Portland*. The reports of the storm received from other observers, however, confirm the second supposition. Thus the log of the U. S. revenue cutter *Thetis*, lying in Dutch Harbor, Unalaska Island (latitude 54° N., longitude 166° W.), shows that during the twenty-four hours intervening between 1 a. m. of September 11 and 1 a. m. of September 12 the barometer fell from 29.59 inches to 28.67 inches, the winds meanwhile backing from south-southeast, force 5, to east-northeast, force 10. At 6 a. m. of September 12, the barometer of the *Thetis* reached its lowest point, 28.55 inches, wind north, force 10, backing to northwest and west, showing that the center was steadily advancing, and also that the vessel lay to the north or on the left hand of the storm track.

At 8 p. m. the pressure, according to the *Portland's* self-registering aneroid, became almost stationary, and so continued, with winds of diminishing force, until 4 a. m. of the following day, at which time the decrease of pressure recommenced and continued until 3 p. m., when the minimum, 29.12 inches, was reached. From the hour at which this second fall set in the shifts of the increasing winds were steadily westward, passing through south about the time of lowest barometer, showing that the position of the *Portland* was to the southward or right of the line along which the center of the storm was traveling, just as the shifts observed by the *Thetis* showed that the latter vessel lay to the north or left of the track. Immediately after the minimum a

steady rise set in, the winds continuing to veer without interruption, but at the same time diminishing in force, while the weather continued to improve until normal conditions were reestablished. A practically similar sequence of wind and weather may be noted for each depression shown by the curve.

For strictly accurate observations aboard ship the aneroid barometer can never take the place of the mercurial. For ordinary daily use, however, the self-registering aneroid has much to recommend it in the fact that it furnishes automatically a complete record of the changes which take place between the hours of observation, and this in the shape of a continuous curve, as shown in the diagram—a shape which is much more intelligible to the ordinary observer than a series of figures. Especially is such a record of importance in the tropics, where the only variation to which the barometric pressure is subject under normal conditions is the daily double oscillation, which by the use of the self-registering aneroid is made apparent to the eye. In these waters one of the most unfailing indications of the approach of a hurricane is the interruption of this wave-like motion in the pressure, and in the curve drawn by the self-registering aneroid such an interruption can not escape notice, while its detection in the case of a mercurial barometer demands a series of (at least) hourly readings, each of which must be corrected for temperature before tabulation.

Turning now to the ordinary aneroid, it is hard to imagine a case in

which the self-registering instrument can not be substituted for it with advantage. Both instruments are, of course, liable to be disturbed by an accidental jar or shock. In such an event the index hand of the aneroid furnishes no intimation of the occurrence, whereas the self-registering instrument will reveal at a glance both the time and the extent of the disturbance. The determination of the initial error by means of comparison with a standard mercurial is also much simplified in the case of the recording instrument. The cost of the latter is but slightly greater than that of the ordinary aneroid, and the only additional trouble entailed is the weekly task of placing the paper upon the cylinder and winding the clock.

The only point upon which confusion may arise in the use of these instruments is in respect to the time. If the clock is started in accordance with San Francisco time, for example, the entire sheet will, of course, represent the local time of that port, and the successive noons and midnights will denote, respectively, noon and midnight for San Francisco. To convert the hours shown upon the barogram into ship's (local) time, a correction must therefore be applied to the indicated times, the amount of which will depend upon the longitude east or west of San Francisco, or of whatever port or longitude is represented by the sheet. A note should always be made on the sheet, stating with what local time it corresponds. The initial error of the aneroid as determined by comparison with a standard mercurial should also be stated.

NOTE BY THE EDITOR.

THE METEOROLOGICAL CENTURY.

The question as to when the nineteenth century ends has been widely discussed. It is evident that we are using the word century in two slightly different significations, viz., either as a consecutive interval of time, or as a series of isolated numbers or things. From the latter point of view we speak of the numbers 1 to 100, or 0 to 99 as a century. On this basis we have a century of poems, or men, or other integral units, and a century of years may begin and end when we will. On the other hand we may use the word century as an interval of time; thus, from the beginning of any epoch to the end of the first year is an interval of one year. In mathematical language we indicate any portion of this year by a cipher followed by a decimal point and the proper numerals. When 99.99 years have elapsed we are near the close of the first century of elapsed time. As a series of numbers 1900 is the first year of the twentieth century. As a record of elapsed time January 1, 1901 is the beginning of the twentieth century.

The Meteorological Congresses and Committees meeting at Leipsic, 1872, Vienna, 1873, Utrecht, 1874, Rome, 1879, Paris, 1885, Zurich, 1888, Munich, 1891, Paris, 1896, adopted resolutions requiring that the following system be adopted in taking averages of meteorological data.

(a) This century is to be divided into decades. The first decade begins January 1, 1801, and ends with December 31, 1810, inclusive. This may be divided up into two lustrums, beginning, respectively, January 1, 1801, and January 1, 1806.

In other words the meteorological century begins with January 1 of the year one, and ends with December 31 of the year 100, and so for each successive century.

(b) The year is to be divided into pentades of five days each, as first used by Dove. The first pentade includes the whole of January 1, 2, 3, 4, and 5. There are therefore 73 pentades in the year. When leap year occurs the pentade in which February 28 occurs is to include the 29th also, and, therefore, has six days in place of five.

(c) The day is divided into twenty-four hours, beginning and ending at midnight, mean local time. The first observation of the day is to be that taken at 12 o'clock, midnight, or 24 o'clock, midnight, if a 24-hour numeration be used. The numeration 24 m., 1 a. m., 2 a. m.—24 m. is to be preferred to the numeration 0 m., 1 a. m.—23 p. m., 0 m.; but the latter may be used in the publication of meteorological tables. The expression 12 p. m. is recommended for the midnight hour, and 12 a. m. for the midday hour in case the numeration 1^h—24^h is not used.

(d) In taking daily means of twenty-four hourly observations the formula indicated by the method of quadratures is to be followed, viz:

$$\text{Daily mean} = \frac{[\frac{1}{2}(24^h_1 + 24^h_2) + 1^h + 2^h \dots + 23^h]}{24}$$

The first twelve hours, viz, 1 to 12 are to be considered as belonging to the morning; the following twelve, viz, 13 to 24 as belonging to the afternoon.